PL-ISSN 1895-3131 (print), ISSN 2081-7495 (online) *Acta zoologica cracoviensia*, **54B**(1-2): XX-YY, Kraków, 30 June, 2011

doi:10.3409/azc.54b_1-2.05-15

Contribution to an understanding of the biology and the morphology of the early stages of a Neotropical larentine: *Hagnagora vittata* PHILIPPI, 1859 in Chile (Insecta: Lepidoptera: Geometridae)

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Received: 4 March 2011
Accepted:18 April 2011

KING G. E., PARRA L. E. 2011. Contribution to an understanding of the biology and the morphology of the early stages of a Neotropical larentine: *Hagnagora vittata* PHILIPPI, 1859 in Chile (Insecta: Lepidoptera: Geometridae). *Acta zoologica cracoviensia*, **54B**(1-2): 5-15.

Abstract. Neither the biology nor the early stages of the Neotropical larentine *Hagnagora vittata* PHILIPPI, 1859 (Insecta: Lepidoptera: Geometridae) are known, in the present paper original data are presented on the insect's food-plant in captivity, observations of the imago in the wild state, in addition to details on the morphology of the egg, the fifth instar larva and the pupa.

Key words: Larentiinae, Geometridae, biology, early stages, Chile.

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I. INTRODUCTION

The Neotropical Larentine genus *Hagnagora* DRUCE, 1885 includes 14 species in the Neotropical Region (SCOBLE 1999; BREHM & SULLIVAN 2005), with three (21. 4%) species being present in Chile, these are: *H. discordata* GUENEÉ [1858], *H. mesenata* FELDER & ROGENHOFER, 1875 and *H. vittata* PHILIPPI, 1859 (SCOBLE 1999). In terms of these insects' biology, there is little known, other than the fact that they are diurnal, although the recently described species: *H. marionae* BREHM & SULLIVAN, 2005, is noted as being also active at night (BREHM & SULLIVAN 2005). Despite there also being three species in Ecuador, in addition to there being papers published on Ecuadorian geometrid larval food plants (BREHM 2003; BODNER *et al*. 2010), there is no data available either on this aspect of their biology.

Hagnagora vittata PHILIPPI, 1859, endemic to Chile, was described from Valdivia, Región de los Ríos, Chile (SCOBLE 1999) and included amongst the Chilean Geometrid fauna as *Scordylla vittata* PHILIPPI, 1860, along with *S. mesenata* (FELDER & ROGENHOFER, 1875), (ANGULO & CASANUEVA 1981).

II. STUDY AREA

An area within the limits of the University of Concepción campus with evident anthropogenic influence (plantations of *Pinus radiata* and *Eucalyptus* spp.), that would have corresponded to the concept of 'sclerophyllous woodland (Concepción)' according to GAJARDO (1994) to be found between the rivers Itata and Biobío (central south Chile; 200-400m, 36-38°S). For CAVIERES *et al.* (2005), the aforementioned pine and gum tree plantations have an important presence in the 'Cordillera de la Costa' and can be considered an important threat to the indigenous flora.

III. MATERIAL AND METHODS

Observations were made of imago flight activity in the area under study, normally in late afternoon (Table I). In order that females should oviposit in captivity, examples were confined in a small plastic tub covered with netting and placed in a bright window of the laboratory in line with BODNER *et al.* (2010), females were confined with a sprig of *Teline*

Table I

Hagnagora vittata PHILIPPI, 1859. Basic observations *en visu* in anthropogenically-modified secondary woodland; University of Concepción, Chile

Date	Quantity of imagines	Observation
21.XI.10	1	Imago observed flying around *Teline monspessulana* (Fabaceae). No oviposition noted.
22.XI.10	2	Imagines observed flying around *Teline* (1900 hours). No oviposition noted.
23.XI.10	3	Imagines flying in the vicinity of various shrubs. No oviposition noted.
24.XI.10	3	Imagines flying in the vicinity of various shrubs. No oviposition noted.
27.XI.10	3	Imagines flying from 1230 hours, despite wind. No oviposition noted.
28.XI.10	7	Examples flying even amongst low level vegetation both in areas exposed to the sun as well as in the shade. No oviposition noted.
29.XI.10	2	Examples flying amongst low vegetation and resting on same. No oviposition noted.
4.XII.10	1	Single worn male captured, no other examples seen.
5.XII.10	3	Single example noted feeding from flowers of *Medicago lupulina* (Fabaceae).
8.XII.10	6	Examples noted flying singly in amongst the undergrowth.
21.XII.10	1	
23.XII.10	1	
Total days: 12.	Total: 33	

offered as a possible substrate for egg-laying. Larvae were reared in simple hermetically-sealed plastic containers in the laboratory under normal ambient temperatures of the early austral summer season.

Morphological terms used in this paper: for the egg, SALKELD (1983) and YOUNG (2006); for the larva STEHR (1987), and for the pupa PATOĆKA (1994).

IV. RESULTS

Table I details the observations made of imago flight activity in the area under study.

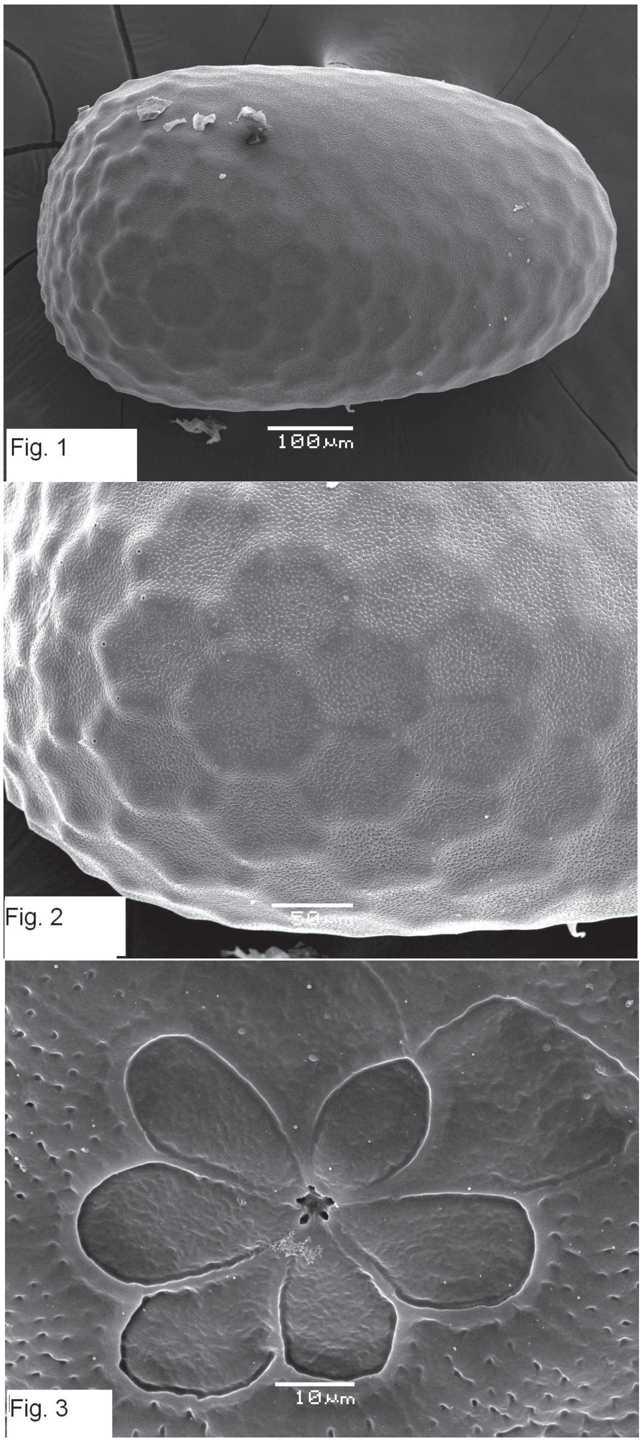
Two females were captured, one specimen (♀12.XI.10; Hualpén, VIII Región, 130-200 m, Luis E. PARRA *leg et det.)* was confined in a plastic box but did not lay any ova; the second specimen (♀29.XI.10; university campus, Concepción, Región de Biobío, G. E. KING *leg et det*.) laid ova overnight: eggs were laid individually; 33 in total: six were laid on a dried sprig of *Teline monspessulana* (L.) K. KOCH (18. 2%), whilst 27 (82%), were laid liberally on the netting; the female perished the following day. The initial neonate was observed 4.XII.10 (c. 5 days incubation period); but this did not eat *Teline* as offered, at this stage, as food-plant data was unavailable, it was decided to offer leaves of those plants found in the imago's habitat and amongst which it was noted flying and/or resting, these plants included: *Chusquea quila* KUNTH. (Poaceae), *Lupinus arboreus* SIMS, *Teline monspessulana* (Fabaceae), *Calceolaria* sp. (Scrophulariaceae) and *Fuschia magellanica* LAM. (Onagraceae). Three larvae (9. 1%) eclosed 7.XII.10 (c. 8 days) and the remainder 29 (87. 9%) 8.XII.10 (c. 9 days); of the plant sprigs made available, the only plant attacked was *Fuschia*, larvae initially 'scratching' the parenchyma of the upper leaf surface and made tiny holes in the leaves; 1st ecdysis noted 11.XI.10 (c. 4 days in 1st instar); 2nd ecdysis 14.XII.10 (c. 3 days in 2nd instar); 4th ecdysis 23.XII.10 (c. 8 days across two instars); measurements of L5 larvae 17. 6mm (=5); first two larvae pupated 30.XII.10 (c. 7 days in final instar = c. 27 days in whole larval stage), but did not produce a cocoon, these L5 larvae were noted as being ready to enter into the pre-pupal phase by their quiescent state and the swollen aspect of the anterior segments; overall colouration: brownish green; initial pupae were observed 6.I.11 (c. 6 days in the pre-pupal phase); pupa: glossy black with reddish-ochre abdominal interstices; ♂♂ 9. 4 mm (n=3); ♀♀ 9. 3mm (n=12); larva pupates in a light reddish-brown cocoon spun between dry leaves, although a cocoon is not always constructed, at least not in captivity.

Description of ovum

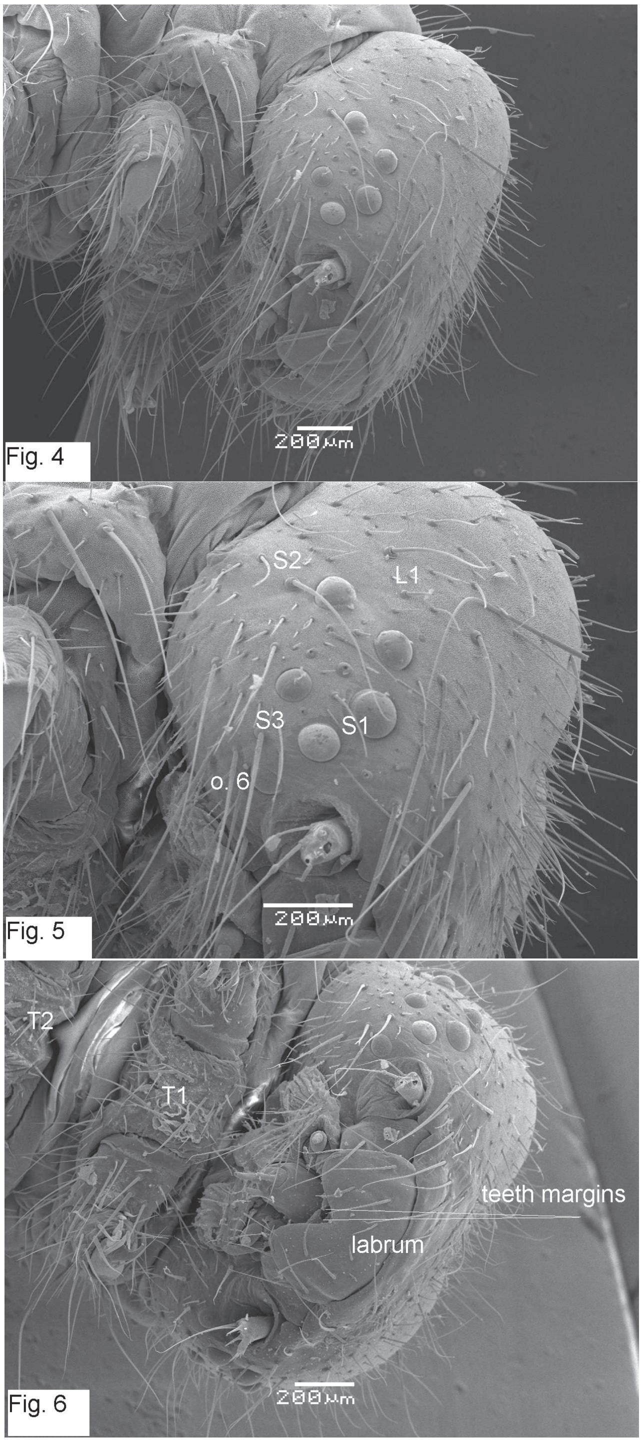
Ova on being laid are creamy-white and are of the horizontal type as described by SYME (1961) where the egg is laid on its side parallel to the substrate (Fig. 1). According to SALKELD (1983), the surface of the ovum would be described as smooth being marked with slightly irregularly arranged polygonal cells (Fig. 2). YOUNG (2006) describes the 'r-osette' as the inner ring of cells surrounding the micropyle, which in *H. vittata* number six with a distinctive 'petal' shape (Fig. 4).

Description of L5 larva

Cephalic capsule (Fig. 4): hypognathous; there are six stemmata with a slighter smaller ocello 3 being positioned away from the group which as a whole form a rough 'seven' figure; S2 alongside ocello 1; S1 alongside ocello 4; S3 positioned at equidistance between ocello 5 and 6; L1 positioned mid-way laterally up from ocello 1 (Fig. 5); the teeth are quite clearly indented (Fig. 6); thoracic region: T1: setae are dark ochre; XD2 (unable to appre-



Figs 1-3. Ovum of *Hagnagora vittata* PHILIPPI, 1859: 1 – lateral view; 2 – ovum surface; 3 – rosette and micropyle.



Figs 4-6. Larva L5 of *Hagnagora vittata* PHILIPPI, 1859. 4 – cephalic capsule lateral view; 5 – stemmata and corresponding setae; 6 – cephalic capsule; T1 ventral view.

ciate), XD1; D1, D2, SD2; lateral setae L1, L2, L3 are to be found anterior to the spiracle (Fig. 7), with L1 especially long, being more than twice as long as L2; SV2, SV1 (Fig. 7); T2: D2, SD1; once again, L1 is the longest of the setae, which with L2 and L3 forms an isosceles triangle; SV1 (Fig. 8); abdominal region: A1: D1, D2, SD1 are the longest setae in the dorsal region; directly above the spiracle is SD1, below this structure SV2 and L3 which is longer and darker than the other setae (Fig. 9); A6: the lateral setae are present on a pronounced flap superior to the anal pro-leg; L1 being twice as long as L2 and longer than L3 (Fig. 10), the sub-ventral setae are well-represented on the anterior surface of the aforementioned structure: SV1-SV6; SV3 and SV6 being the lengthiest of the group; the pro-leg uniserial-uniordinal crochets are divided into a series of two of six and then nine each (Fig. 10); A7; A8: on these segments the lateral seta L1 seems characteristically lengthy in comparison with other setae (Fig. 11); A9: the three lateral setae are to be found in descending vertical order L2, L1 and L3; there are two sub-ventral setae alongside each other SV1, SV2; V1 present (Fig. 12); A10: anal shield with setae: D1, D2, SD1; in the anterior region setae: PP1, SV1 with L1 being the longest seta on the anterior region of the abdominal pro-legs (Fig. 13); crochets of abdominal pro-legs divided into a series of rows of eleven each (Fig. 14).

Description of pupa

Pupa has a slight granular appearance (Fig. 16); cremaster has a pair of relatively straight hooks which correspond to D2 as indicated by PATOĆKA (1994) (Fig. 15).

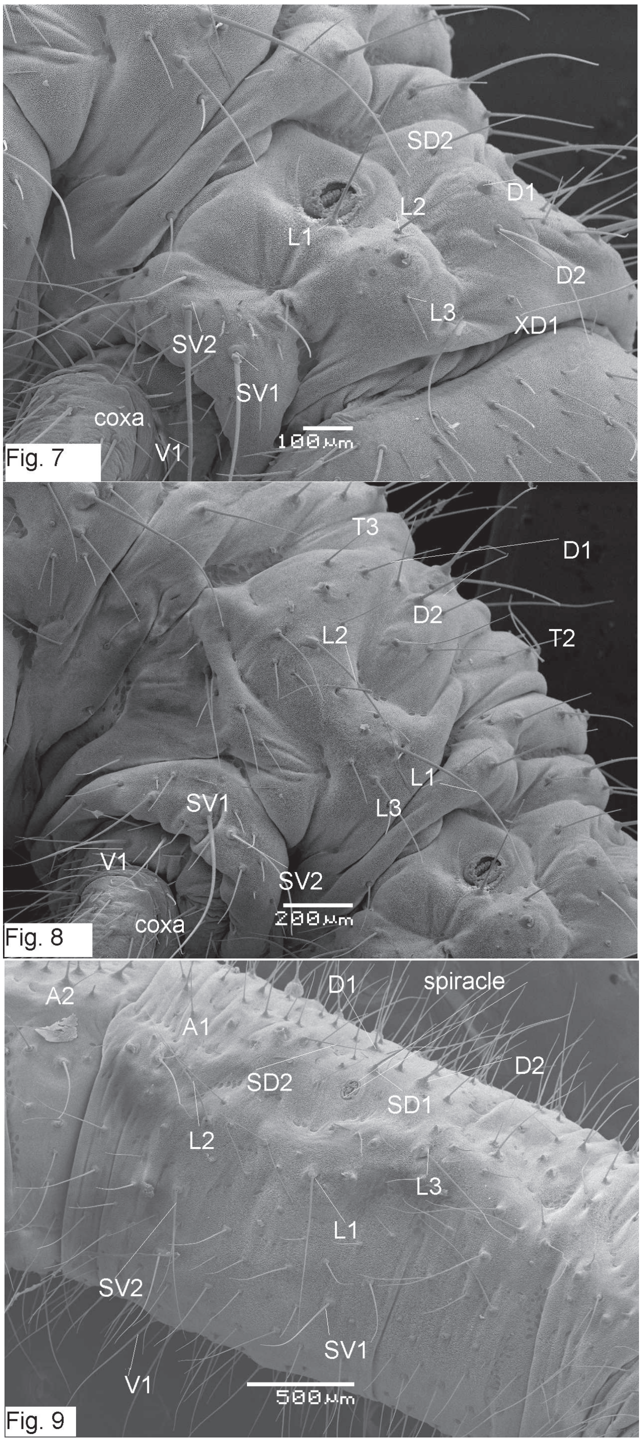
V. DISCUSSION

In the present paper original data has been presented on the biology of the Chilean endemic species *Hagnagora vittata*, taking in observations of the imago in its natural habitat in Concepción, describing the process of oviposition in captivity and detailing the discovery of *Fuschia magellanica* as its food-plant in captivity, but quite possibly also in the natural state. Morphological detail has also been given on the ovum, larva and the pupa.

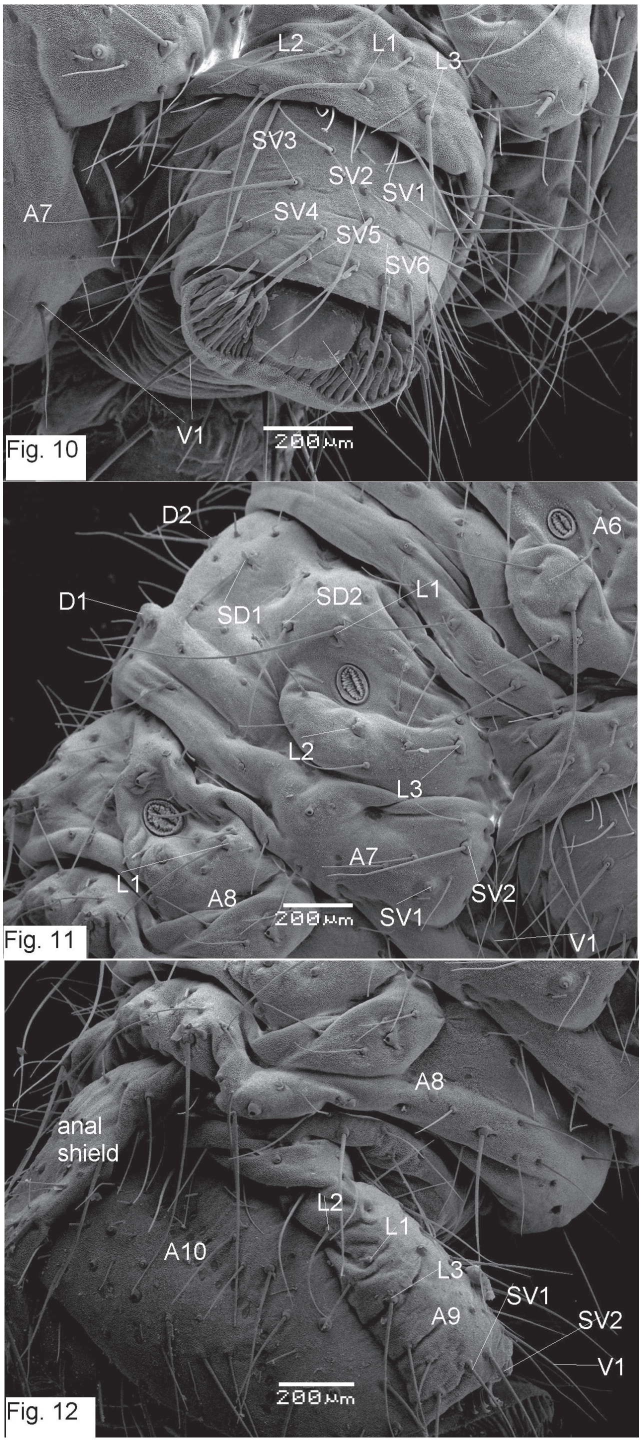
This diurnal species must also exhibit nocturnal activity, as ova were found in captivity in the morning after capture of the female this dual behavioural pattern has also been demonstrated in *Hagnagora marionae* in Costa Rica (BREHM & SULLIVAN 2005). That the females oviposit nocturnally is interesting, despite the observation of thirty-three imagines over twelve days in the natural state, no apparent oviposition activity was observed, although imagines posing on a variety of substrates was recorded (Table I).

BREHM (2002) indicates the fact that the larval biology of the Ennominae is better documented than that for the Larentiinae in the Neotropics, for sure, there is no mention of *Fuschia* in that author's assessment of Neotropical Geometrid food-plants. The use of *Fuschia magellanica* as a food-plant by *H. vittata* may or may not indicate a relationship between this onagracea and the genus *Hagnagora*, the only data available of a Neotropical geometrid using *Fuschia* is that of *Isochromodes fraterna* WARREN, 1904 (Geometridae: Ennominae) on *Fuschia lehmannii* MUNZ in Ecuador (BODNER *et al*. 2010).

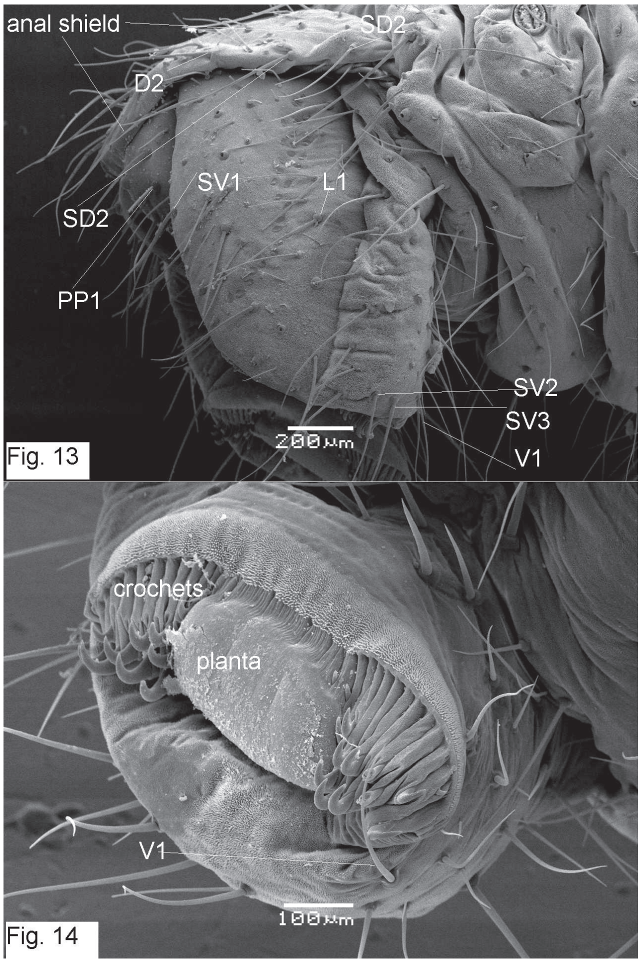
Knowledge of the morphology of the early stages of the Neotropical larentine species is woefully incomplete, therefore making it difficult to situate the present findings in some



Figs 7-9. Larva L5 of *Hagnagora vittata* PHILIPPI, 1859. 7 – T1 and corresponding setae; 8 – T2 and corresponding setae; 9 – A1 and corresponding setae.



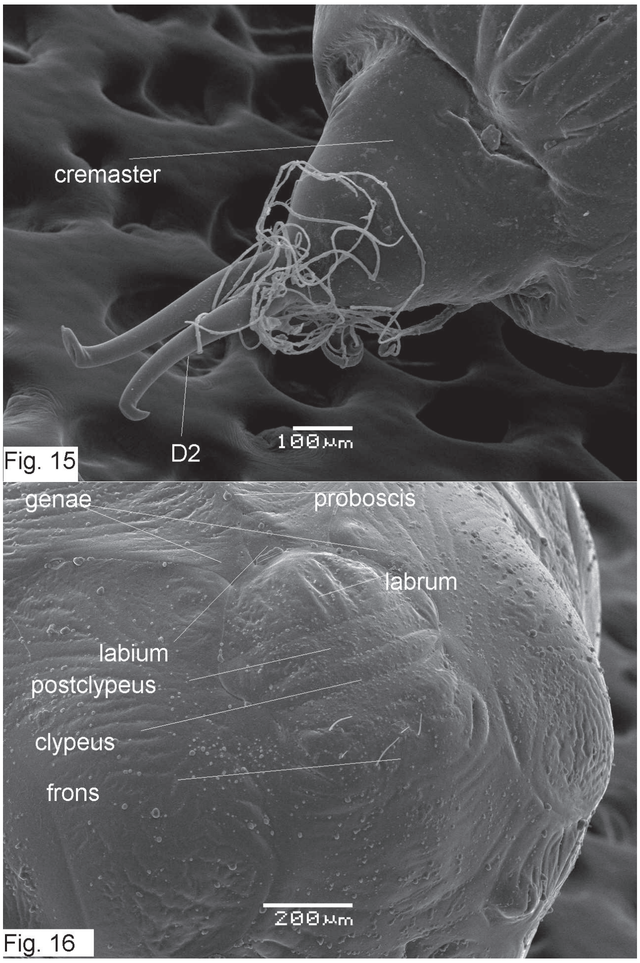
Figs 10-12. Larva L5 of *Hagnagora vittata* PHILIPPI, 1859. 10 – A6 abdominal proleg lateral view and corresponding setae; crochets; 11 – A6, A7, A8 with corresponding setae; 12 – A9 with corresponding setae.



Figs 13-14. Larva L5 of *Hagnagora vittata* PHILIPPI, 1859. 13 – A10: anal shield; abdominal pro-leg; corresponding setae; 14 – abdominal pro-leg and crochets.

meaningful taxonomic context this present work continues that initiated by IBARRA-VIDAL & PARRA (1993) and VARGAS *et al.* (2002) with their studies of *Eupithecia horismoides* RINDGE, 1987 and *E. sibylla* BUTLER, 1882, respectively.

A c k n o w l e d g e m e n t s. Most grateful thanks to the Research Section of the Universidad Autónoma de Madrid for the concession of a grant in 2010 under the auspices of Project 541D708 and 541D731 (Nov. 2010-Jan. 2011) which enabled the first-named author to travel to Chile. Also to Project 210.113.079-1.0 of the Dirección de Investigación and also to the laboratory staff (especially to Hugo PACHECO and Julio PUGIN) of the Scanning Electronic Microscope of the University of Concepción, Chile.



Figs 15-16. ♀ pupa of *Hagnagora vittata* PHILIPPI, 1859. 15 – posterior zone ventral view: cremaster and hooks; 16 – anterior zone ventral view with terms according to PATOĆKA (1994).

REFERENCES

ANGULO A. O., CASANUEVA M. E. 1981. Catálogo de los Lepidópteros Geométridos de Chile (Lepidoptera: Geometridae). *Boletín de la Sociedad de Biología de Concepción*, Tomo **LI**: 7-39.

BREHM G. 2002. Diversity of geometrid moths in a montane rainforest in Ecuador. PhD. Thesis, University of Beyreuth, available on-line: http://opus.ub.uni-beyreuth.de/volltexte/2003/20 pp. 196.

BREHM G. 2003. Host-plant records and illustrations of the larvae of 19 geometrid moth species from a montane rainforest in Ecuador (Lepidoptera: Geometridae). *Nachrichten des Entomologischen Vereins Apollo*, N.F. **24**: 29-34.

BREHM G., SULLIVAN B. 2005. Unusual flight activity of a new species of *Hagnagora* DRUCE, 1885 (Lepidoptera, Geometridae) from Costa Rica. *Entomologische Zeitschrift*, **115**: 256-260.

BODNER F., BREHM G., HOMEIER J., STRUTZENBERGER P., FIEDLER K. 2010. Caterpillars and host plant records for 59 species of Geometridae (Lepidoptera) from a montane rainforest in southern Ecuador. *Journal of Insect Science*, 10: article **67**: 1-22.

CAVIERES L. A, MIHOC M., MARTICORENA A., MARTICORENA C., BAEZA C. M., ARROYO M. T. K. 2005. Flora vascular de la Cordillera de la Costa en la región del Biobío: riqueza de especies, géneros, familias y endemismos [In:] C. SMITH-RAMÍREZ, J. J. ARMESTO, C. VALDOVINOS (eds) – Historia, biodiversidad y ecología de los bosques costeros de Chile. Edición Universitaria, Santiago de Chile, Pp: 245-277.

GAJARDO R. 1994. La vegetación natural de Chile. Clasificación y distribución geográfica. Edición Universitaria, Santiago, Chile, 165 pp.

IBARRA-VIDAL H., PARRA L. E. 1993. Descripción de los estados preimaginales y aspectos de la historia natural de *Eupithecia horismoides* RINDGE, 1987 (Lepidoptera, Geometridae), perforador del peciolo del pangue (*Gunnera tinctoria*). *Revista Chilena de Entomología*, **20**: 35-41.

PATOČKA J. 1994. Die Puppen der Spanner mitteleuropas (Lepidoptera: Geometridae): Charakteristik und bestimmungstabelle der Gatungen. *Tijdschrift voor Entomologie*, **137**: 27-56.

SALKELD E. H. 1983. A catalogue of the eggs of some Canadian Geometridae (Lepidoptera), with comments. .*Memoirs of the Entomological Society of Canada*, **126**: 1-271.

SCOBLE M. J. 1999. *Geometrid Moths of the World: a catalogue* (Lepidoptera, Geometridae) vols. 1 & 2; CSIRO Publishing & Apollo Books, Stenstrup, Denmark, 1016 pp; 129 Index pp.

STEHR F. W. 1987. *Immature insects*. Kendall/Hunt Publishing Company, Dubuque, Iowa, USA.

SYME P. D. 1961. The morphology of lepidopterous eggs, with descriptions of two hundred and forty-eight species. Ph. D. Thesis (unpublished), University of Toronto, Canada.

VARGAS H. A., PARRA L. E., BOBADILLA D. E. 2002. Aspectos biológicos de *Eupithecia sibylla* BUTLER, 1882 (Lepidoptera: Geometridae). *Gayana (Concepción),* **66**(2): 103-106.

YOUNG C. J. 2006. Descriptions of the eggs of some southern Australian Geometridae (Lepidoptera). *Zootaxa*, **1287**: 294 pp. Magnolia Press, Aukland, New Zealand.